525 Rec'd PCT/PTO 29 NOV 2000

FORM PTO-1390 U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 46890-466

U.S. APPLIC. NO. (if known, see 37 CFR 1.5): 09/701479

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP00/01784	March 23, 2000	March 29, 1999

TITLE OF INVENTION

X-RAY CAMERA

APPLICANT(S) FOR DO/EO/US

Toshiyoshi YAMAMOTO, Takuo SHIMADA, Atsushi SAKATA, Kazuya KONDO, and Yoshihiro INO

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.

3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)

6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☒ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendment has NOT expired.
   d. ☐ have not been made and will not be made.

8. ☒ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.

14. ☐ A substitute specification.

15. ☐ A change of power of attorney and/or address letter.

16. ☒ Other items or information.

International Search Report prepared by JPO
Forms PCT/IB/301, PCT/IB/304, PCT/IB/308, and PCT/IB/346
Front page of published International application

525 Rec'd PCT/PTO 29 NOV 2000

U.S. APPLIC. NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/701479	PCT/JP00/01784	43890-466

	CALCULATIONS	PTO USE ONLY
17. ☒ The following fees are submitted:		
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO $860.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) $690.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $710.00		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,000.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860 00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☒ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ 130.00	

Claims	Number Filed	Number Extra	Rate		
Total Claims	14 -20 =	0	x $18.00	$	
Independent Claims	3 -3 =	0	x $80.00	$	
Multiple dependent claim(s) (if applicable)			+ $270.00	$	
			TOTAL OF ABOVE CALCULATIONS =	$ 990.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
			SUBTOTAL =	$ 990.00	
Processing fee of $130.00 for furnishing the English translation later than the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
			TOTAL NATIONAL FEE =	$ 990.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
			TOTAL FEES ENCLOSED =	$ 990.00	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of $ _____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 500417 in the amount of $ 990.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 500417. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

McDERMOTT, WILL & EMERY
600 13th Street, N.W.
Washington, DC 20005-3096
(202) 756-8000
Facsimile (202) 756-8087

SIGNATURE
Michael E. Fogarty
NAME
36,139
REGISTRATION NUMBER
November 29, 2000
DATE

ASED ON FORM PTO-1390 (Rev. 5-93)

09/701479
525 Rec'd PCT/PTO 29 NOV 2000

Docket No.: 43890-466 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	
	:	
Toshiyoshi YAMAMOTO, et al.	:	
	:	
Serial No.:	:	Group Art Unit:
	:	
Filed: November 29, 2000	:	Examiner:
	:	
For: X-RAY CAMERA		

REQUEST FOR APPROVAL OF DRAWING AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Approval of the changes made to Figures 2A, 3A, 3B, 4, 6A, and 7A, as shown in red ink on the attached photocopies, is courteously solicited.

Respectfully submitted,

MCDERMOTT, WILL & EMERY

Michael E. Fogarty
Registration No. 36,139

600 13th Street, N.W.
Washington, DC 20005-3096
(202) 756-8000 MEF:klm
Date: November 29, 2000
Facsimile: (202) 756-8087

Fig.2A

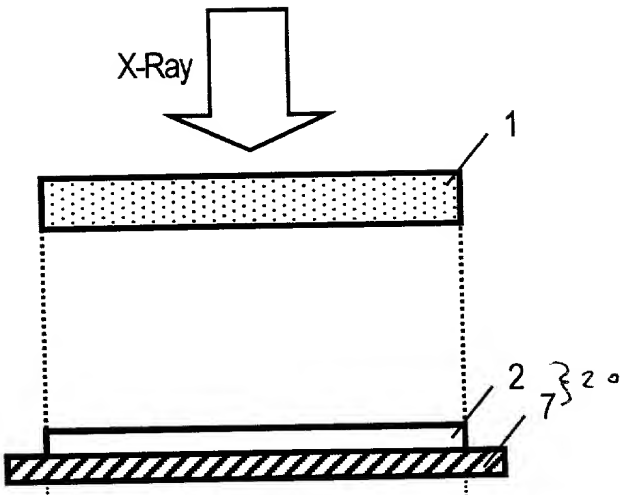


Fig.2B

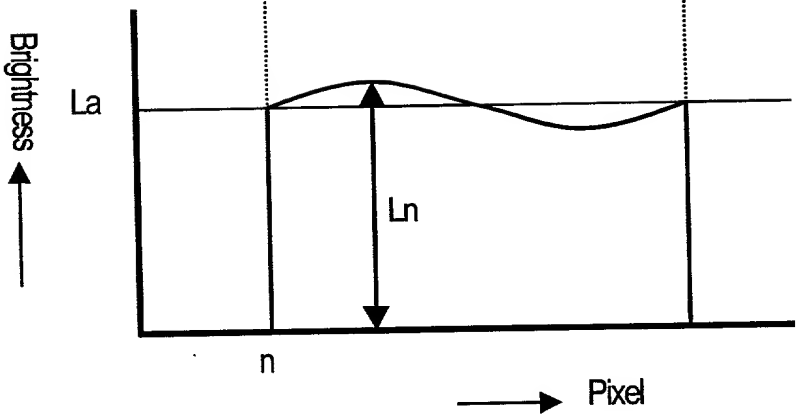


Fig.3A

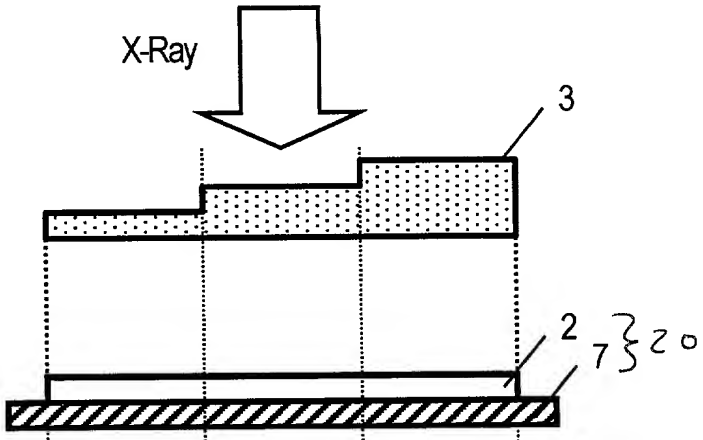


図 3 B

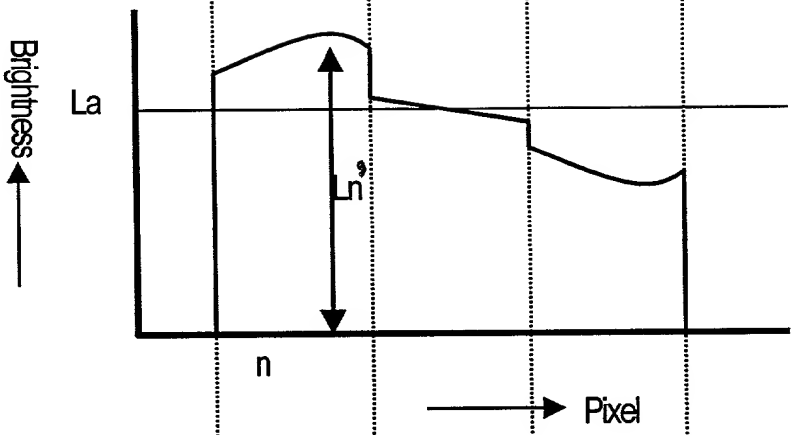


Fig.3C

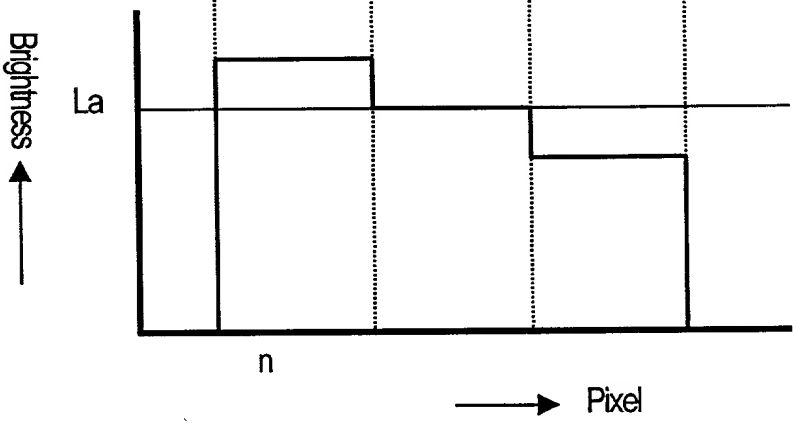


Fig.4

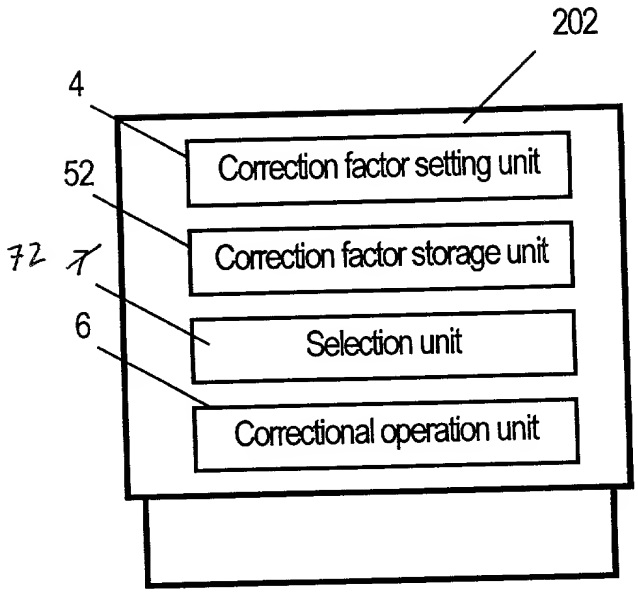

202
4
Correction factor setting unit
52
Correction factor storage unit
72
Selection unit
6
Correctional operation unit

Fig.5

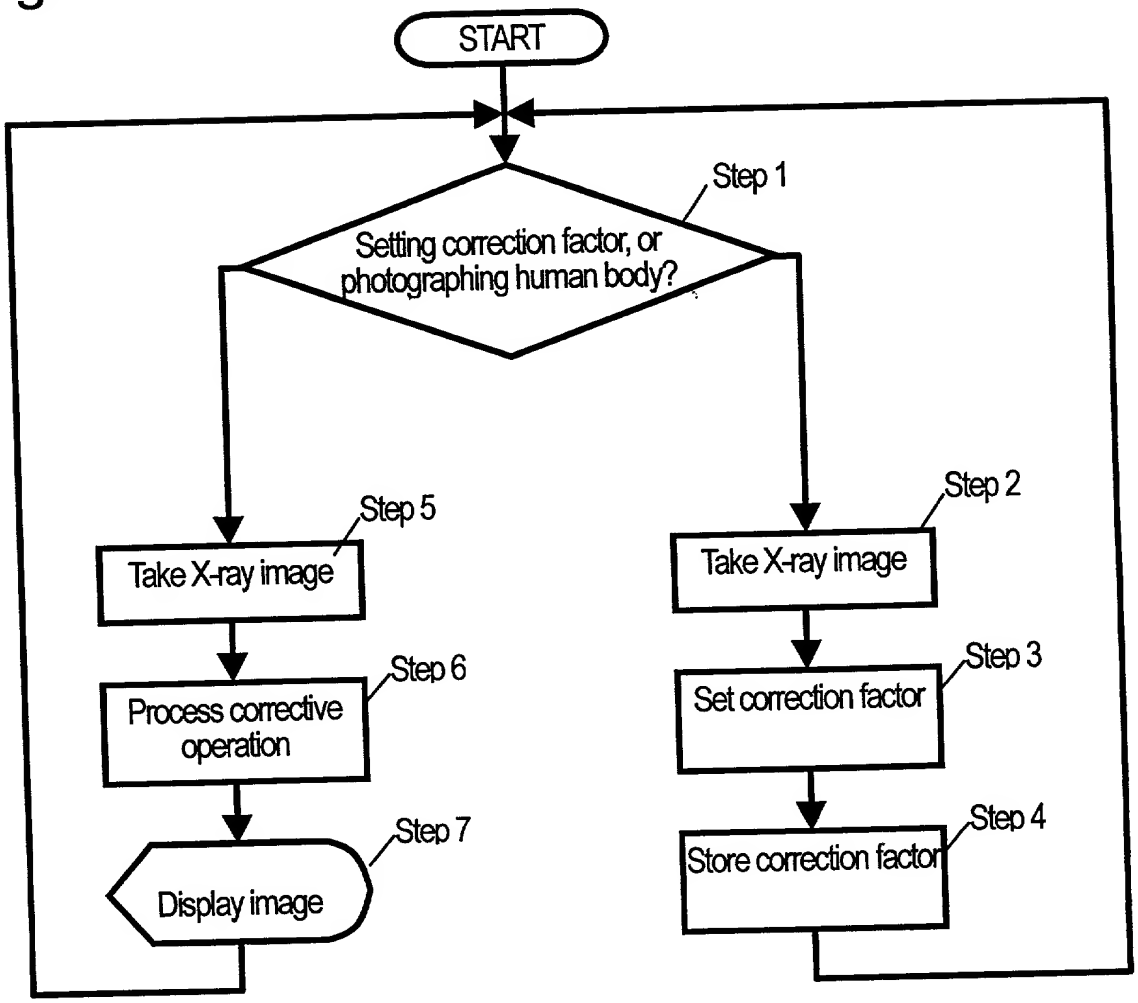

START
Step 1
Setting correction factor, or photographing human body?
Step 5
Take X-ray image
Step 6
Process corrective operation
Step 7
Display image
Step 2
Take X-ray image
Step 3
Set correction factor
Step 4
Store correction factor

Fig.6A

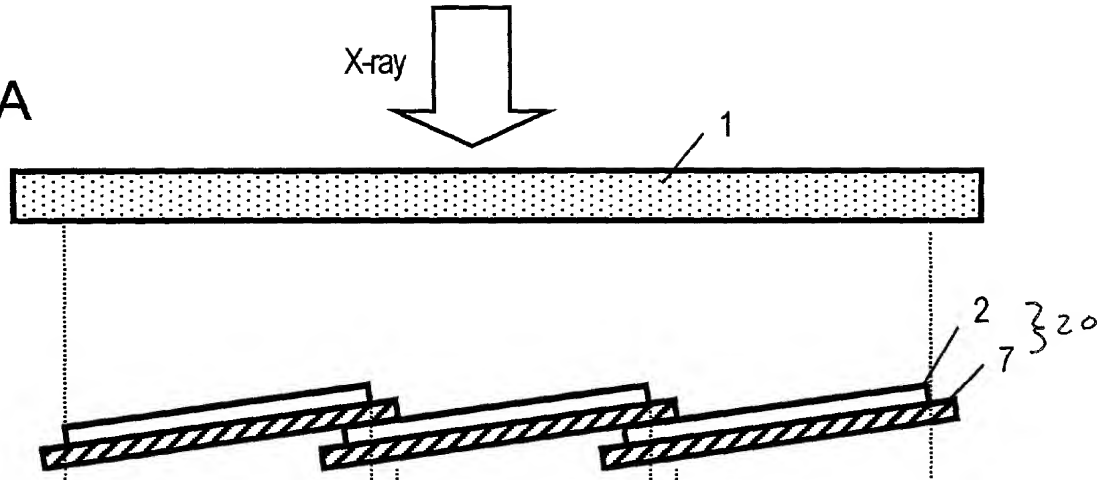
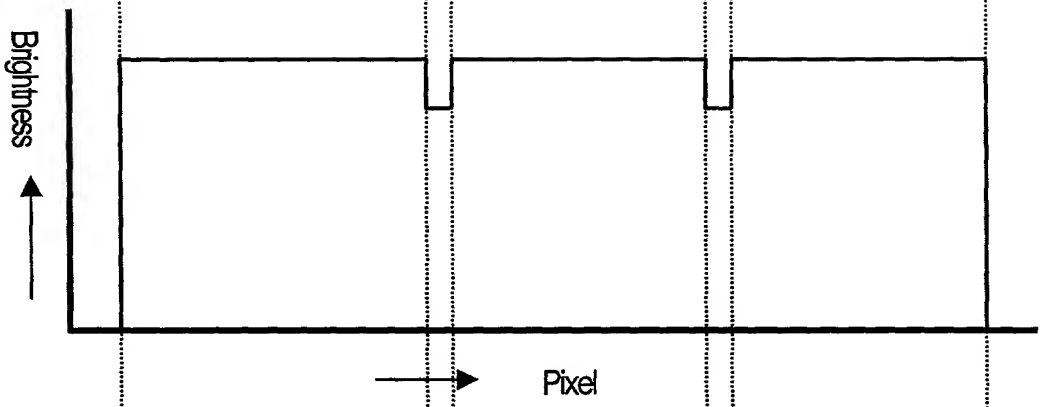


Fig.6B



Correction

Fig.6C

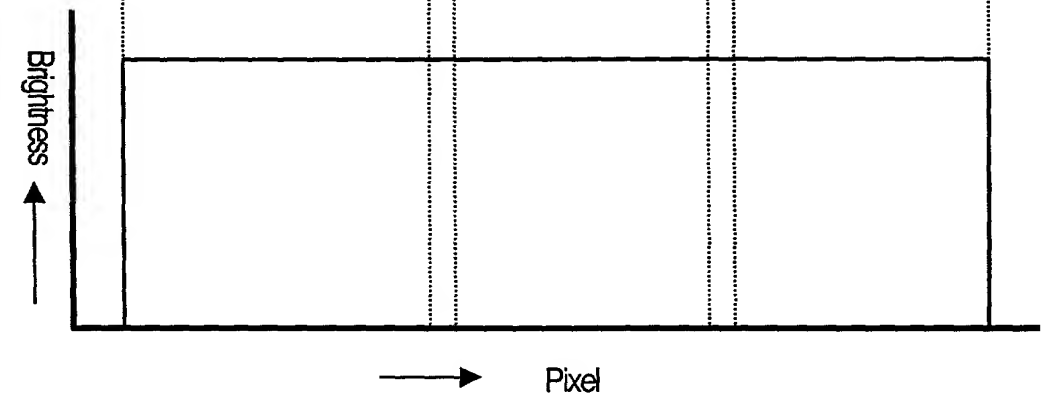


Fig.7A

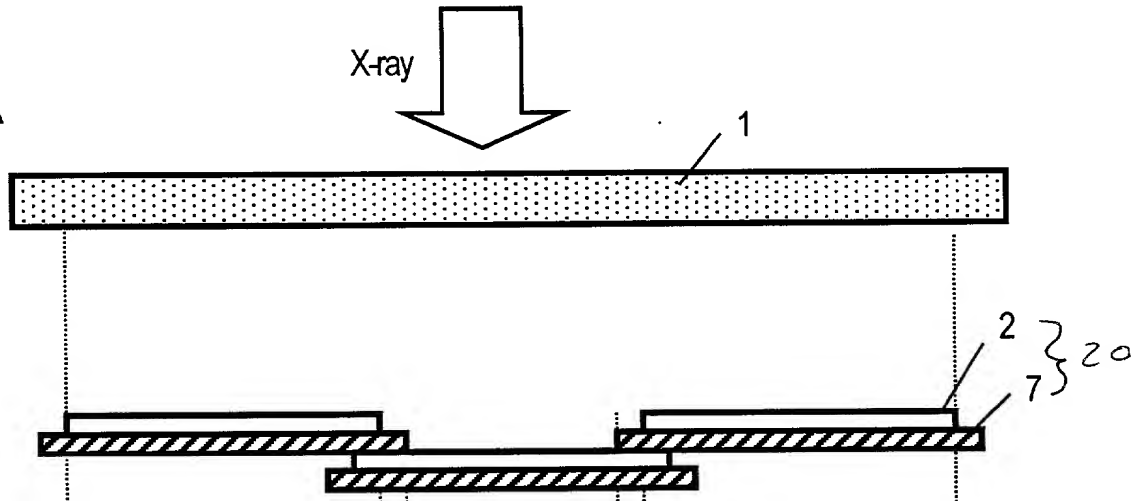
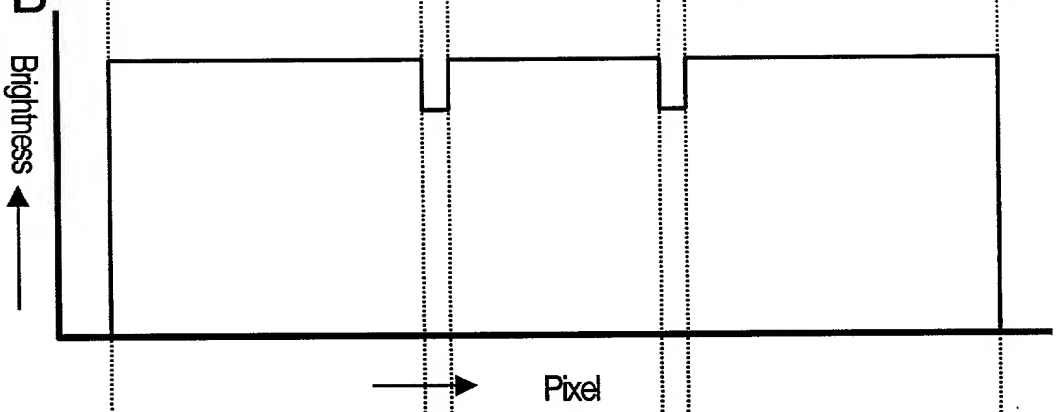
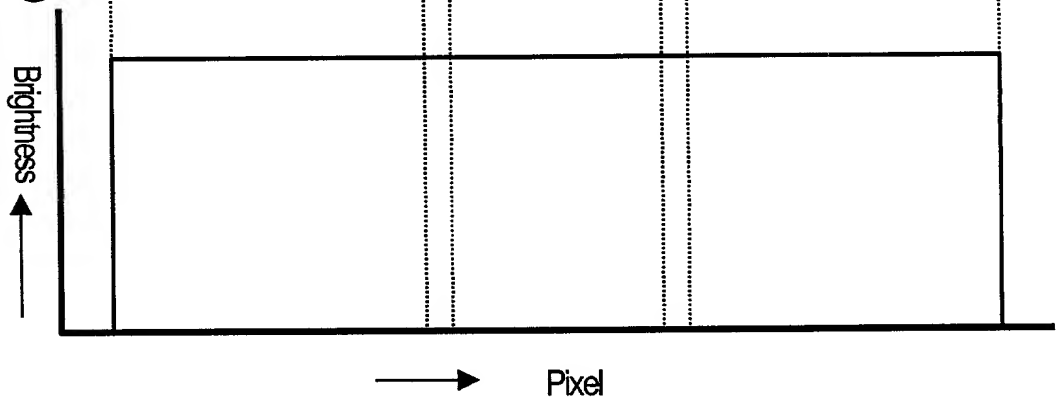


Fig.7B



Correction

Fig.7C



REFERENCE NUMERALS

1. Reference subject

2. X-ray photographic sensor

3. Model subject of step-wise configuration (Subject body)

4. Correction factor setting unit

5. Correction factor storage unit

52. Correction factor storage unit

6. Correctional operation unit

727. Selection unit

100. X-ray irradiation unit

200. Controller

202. Controller

300. Display unit

400. Schematically illustrated subject

P22599.S4.P05.S2

09/701479

525 Rec'd PCT/PTO 29 NOV 2000

Docket No.: 43890-466 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	
	:	
Toshiyoshi YAMAMOTO, et al.	:	
	:	
Serial No.:	:	Group Art Unit:
	:	
Filed: November 29, 2000	:	Examiner:
	:	

For: X-RAY CAMERA

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Prior to examination of the above-referenced application, please amend the application as follows:

IN THE SPECIFICATION:

Page 8, line 4, please change "Fig. 5" to --Fig. 4--.

Page 8, line 15, please change "unit 6" to --unit 72--.

Page 9, line 21, please change "unit 5" to --unit 6--.

Page 10, line 19, please change "unit 7" to --unit 72--.

Page 11, line 7, please change "unit 7" to --unit 72--.

Page 11, line 22, please change "unit 7" to --unit 72--.

IN THE CLAIMS:

Please substitute the attached pages of claims as amended under Article 19 for the claims as filed.

REMARKS

Entry of this preliminary amendment is respectfully requested.

Respectfully submitted,

MCDERMOTT, WILL & EMERY

Michael E. Fogarty
Registration No. 36,139

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Date: November 29, 2000
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PCT/US00/32650

AMENDEDMENT

CLAIMS

1. (Amended) X-ray photographic equipment having an image correction means for improving picture quality of an X-ray photographic image by correcting dispersion in brightness of the [an] image obtained by taking an X-ray photograph of a subject body, using a pixel correction factor acquired from a brightness data representing gradation of an image obtained by taking an X-ray photograph of a reference subject.

2. (Amended) The X-ray photographic equipment as set forth in claim 1, wherein said pixel correction factor for improvement of picture quality acquired from the brightness data representing gradation of the image obtained by taking the X-ray photograph of said reference subject is set therein for each pixel individually.

3. The X-ray photographic equipment as set forth in claim 2, wherein a value acquired by dividing a predetermined brightness reference value with a brightness value of each pixel in the image obtained by taking the X-ray photograph of said reference subject is used as a pixel correction factor for said pixel.

4. (Amended) The X-ray photographic equipment as set forth in claim 3, wherein said image correction means for improving picture quality corrects

brightness of each pixel by multiplying a brightness value of said pixel in the image obtained by taking the X-ray photograph of said subject body by said pixel correction factor of the corresponding pixel acquired by taking the X-ray photograph of said reference subject.

5. The X-ray photographic equipment as set forth in claim 2, wherein a value acquired by dividing an average value of brightness of the image obtained by taking the X-ray photograph of said reference subject with the brightness value of each pixel is used as a pixel correction factor for said pixel.

6. (Amended) The X-ray photographic equipment as set forth in claim 5, wherein said image correction means <u>for improving picture quality</u> corrects brightness of each pixel by multiplying a brightness value of said pixel in the image obtained by taking the X-ray photograph of said subject body by said pixel correction factor of the corresponding pixel acquired by taking the X-ray photograph of said reference subject.

7. The X-ray photographic equipment as set forth in claim 2, wherein a value acquired by dividing a representative value of brightness of the image obtained by taking the X-ray photograph of said reference subject with the brightness value of each pixel is used as a pixel correction factor for said pixel.

8. (Amended) The X-ray photographic equipment as set forth in claim 7, wherein said image correction means <u>for improving picture quality</u> corrects brightness of each pixel by multiplying a brightness value of said pixel in the

image obtained by taking the X-ray photograph of said subject body by said pixel correction factor of the corresponding pixel acquired by taking the X-ray photograph of said reference subject.

9. (Amended) The X-ray photographic equipment as set forth in claim 2, wherein urethane resin for typifying a soft-tissue equivalent material representing muscles and adipose tissue [, composed of urethane resin and the like,] is used as a reference subject for acquiring said pixel correction factor for improvement of picture quality.

10. (Amendment) The X-ray photographic equipment as set forth in claim 2, wherein any of epoxy resin and aluminum typifying a bone-tissue equivalent material [composed of epoxy resin, aluminum and the like] is used as a reference subject for acquiring said pixel correction factor for improvement of picture quality.

11. (Amendment) The X-ray photographic equipment as set forth in claim 2 comprising a storage means for storing a pixel correction factor for each pixel obtained by taking the X-ray photograph of said reference subject, and a correction factor setting means for setting a pixel correction factor, other than ordinary X-ray photography, in order to acquire said pixel correction factor, wherein said X-ray photographic equipment can be operated for resetting a pixel correction factor for improvement of picture quality at an arbitrary timing when said equipment is first installed, when a user determines it necessary, and so on.

12. X-ray photographic equipment comprising:

a storage means for storing a pixel correction factor for each pixel obtained by taking an X-ray photograph of a reference subject;

a correction factor setting means for setting a pixel correction factor, other than ordinary X-ray photography, in order to acquire said pixel correction factor; and

a correction means for correcting brightness of an image obtained by taking an X-ray photograph of a subject body using said pixel correction factor,

wherein said storage means stores three sorts of pixel correction factors obtained by dividing each of three values by a brightness value of said pixel, said three values being an average value and a representative value of brightness of an image obtained by taking the X-ray photograph of said reference subject, and a predetermined reference brightness value , and

said correction factor setting means selects one pixel correction factor among said three sorts of pixel correction factors when making correction of brightness of the image obtained by taking the X-ray photograph of said subject body.

13. X-ray photographic equipment comprising:

a storage means for storing a pixel correction factor for each pixel obtained by taking an X-ray photograph of a reference subject;

a correction factor setting means for setting a pixel correction factor, other than ordinary X-ray photography, in order to acquire said pixel correction factor; and

a correction means for correcting brightness of an image obtained by

taking an X-ray photograph of a subject body using said pixel correction factor,

wherein said storage means stores two sorts of pixel correction factors corresponding to a soft-tissue equivalent material and a bone-tissue equivalent material by taking photographs of said two equivalent materials, and

said correction factor setting means selects one pixel correction factor between said two sorts of pixel correction factors when making correction of brightness of the image obtained by taking the X-ray photograph of said subject body.

14. (Amendment) The X-ray photographic equipment as set forth in claim 1, wherein a plurality of X-ray image sensors are arranged in a manner that a portion of an image-capture area of each said sensor [photographed image] overlaps with one another, in order to take an X-ray image of an expanded size without an error of brightness in the overlapped portion.

Date 28.06.2000

World Intellectual Property Organization
PCT Administration Division
34 Chemin des Colombettes
1211 GENEVA 20
Switzerland

"Amendment of the claims under Article 19(1) (Rule 46)"
Re: International Application No. PCT/JP00/01784
Applicant: Matsushita Electric Industrial Co., Ltd.
Agent: IWAHASHI Fumio
International Filing Date: 23.03.99

Dear Sir.

The Applicant, who received the International Search Report relating to the above identified International Application transmitted on 30.05.00 hereby files amendment under Article 19(1) as in the attached sheets.

Claims 1, 2, 4, 6, 8, 9, 10, 11, 14 have been amended.

Very truly yours,

IWAHASHI Fumio

Attachment:

Amendment under Article 19(1) 4 sheets

PCT/JP00/01784 28.06.2000

請 求 の 範 囲

1. （補正後）基準となる被写体をX線撮影して得られる画像の濃淡をあらわす輝度データから求めた補正係数を用いて、対象となる被写体をX線撮影して得られる画像の輝度バラツキを補正し、X線撮影画像の画質向上のための画像補正手段を有することを特徴とするX線撮影装置。

2. （補正後）前記基準となる被写体をX線撮影して得られる画像の濃淡をあらわす輝度データから求めた画質向上のための補正係数は、それぞれの画素ごとに設定することを特徴とする請求項1記載のX線撮影装置。

3. あらかじめ設定した輝度基準値を、基準となる被写体をX線撮影して得られる画像の各画素の輝度値で除算した値をそれぞれの画素の画素補正係数としたことを特徴とする請求項2記載のX線撮影装置。

4. （補正後）前記画質向上のための画像補正手段は、対象となる被写体をX線撮影して得られる画像の各画素の輝度値に、基準となる被写体をX線撮影して得られた前記画素補正係数を乗算してそれぞれの画素の輝度を補正することとした請求項3記載のX線撮影装置。

5. 基準となる被写体をX線撮影して得られる画像の輝度の平均値を各画素の輝度値で除算した値をそれぞれの画素の画素補正係数としたことを特徴とする請求項2記載のX線撮影装置。

6. （補正後）前記画質向上のための画像補正手段は、対象となる被写体

をX線撮影して得られる画像の各画素の輝度値に、基準となる被写体をX線撮影して得られた前記画素補正係数を乗算してそれぞれの画素の輝度を補正することとした請求項5記載のX線撮影装置。

7. 基準となる被写体をX線撮影して得られる画像の輝度の代表値を各画素の輝度値で除算した値をそれぞれの画素の画素補正係数としたことを特徴とする請求項2記載のX線撮影装置。

8. (補正後)前記画質向上のための画像補正手段は、対象となる被写体をX線撮影して得られる画像の各画素の輝度値に、基準となる被写体をX線撮影して得られた前記画素補正係数を乗算してそれぞれの画素の輝度を補正することとした請求項7記載のX線撮影装置。

9. (補正後)前記画質向上のための補正係数を求めるための基準となる被写体として、筋肉、脂肪などの軟組織等価材料であるウレタン樹脂を用いることを特徴とする請求項2に記載のX線撮影装置。

10. (補正後)前記画質向上のための補正係数を求めるための基準となる被写体として、骨組織等価材料であるエポキシ樹脂，アルミを用いることを特徴とする請求項2に記載のX線撮影装置。

11. (補正後)基準となる被写体をX線撮影して得られる各画素の画素補正係数を記憶する記憶手段と、前記補正係数を求めるために、通常のX線撮影とは別に補正係数の設定を行うための補正係数設定手段を備え、装置の初期設置時あるいは使用者が必要と判断した時など任意のタイミ

ングで、画質向上のための補正係数を再設定するための動作を行えるようにしたことを特徴とする請求項2に記載のX線撮影装置。

12. 基準となる被写体をX線撮影して得られる各画像の画素補正係数を記憶する記憶手段と、

前記画素補正係数を求めるために、通常のX線撮影とは別に補正係数の設定を行うための補正係数設定手段と、

前記補正係数を用いて対象となる被写体をX線撮影して得られる画像の輝度を補正する補正手段と、

を備えたX線撮影装置であって、

前記記憶手段に、基準となる被写体をX線撮影して得られる画像の輝度の平均値と代表値およびあらかじめ設定した輝度基準値の3種類の値を各画素の輝度値で除算して得られる3種類の補正係数を記憶しておき、前記対象となる被写体をX線撮影して得られる画像の輝度を補正するときに、前記補正係数設定手段で、3種類の補正係数のうちのどの補正係数を使用するかを選定するX線撮影装置。

13. 基準となる被写体をX線撮影して得られる各画像の画素補正係数を記憶する記憶手段と、

前記画素補正係数を求めるために、通常のX線撮影とは別に補正係数の設定を行うための補正係数設定手段と、

前記補正係数を用いて対象となる被写体をX線撮影して得られる画像の輝度を補正する補正手段と、

を備えたX線撮影装置であって、

前記記憶手段に、軟組織等価材料と骨組織等価材料の2種類の等価

材料を撮影し、それぞれの等価材料に対応する2種類の補正係数を記憶しておき、

前記対象となる被写体をX線撮影して得られる画像の輝度を補正するときに、前記補正係数設定手段で、2種類の補正係数のうちのどちらの補正係数を使用するかを選定するX線撮影装置。

14. (補正後)複数のX線撮影センサを、それぞれのセンサの撮像領域の一部分が重なり合うように配置して、より広範囲のX線画像を重なり合う部分の輝度誤差なしに撮影できるようにしたことを特徴とする請求項1に記載のX線撮影装置。

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X-RAY CAMERA

FIELD OF THE INVENTION

The present invention relates to X-ray camera used in medical diagnosis, dentistry, and the like.

BACKGROUND OF THE INVENTION

X-ray camera of the kind known heretofore include:

conventional X-ray camera used in medical diagnosis for taking photographs of joint regions such as hands and feet, chest, and so on; and

intraoral X-ray camera and panoramic X-ray camera used in dentistry.

As for the method of displaying images, it has been a general practice to print out X-ray images on films for use as monochrome pictures.

In recent years however, there evolved another method of displaying an image that uses a variety of digital techniques after transferring an X-ray image onto a special fluorescent film.

Some of the techniques proposed for use in the method of displaying images include:

a CR (Computed Radiography) technique, in which a fluorescent image is read by using laser, and stored as a digital image;

a technique, in which a combination of charge coupled device (hereinafter referred to as "CCD") and fluorescent material is used to read directly as a digital image in a similar manner as the video photography; and

a technique, in which a combination of TFT (Thin Film Transistor)

panel and photo diode, in combination with fluorescent material is used to read directly as a digital image in a similar manner as the video photography.

Unlike the case of using films, an X-ray camera that uses the digital techniques as above represents a method of expression, in that the equipment accurately reads an X-ray photographic image pixel by pixel, and composes a complete image by realigning again the individual pixel data obtained therefrom on a display device.

For this reason, any defect of pixels of the CCD, the TFT, and the like, manufacturing dispersion of the reading circuits for individual pixels, and so on are reflected just as they are in the pixel data. This has been the failure peculiar to the digital X-ray photography that deteriorates picture quality of display images as typified by slight variations in brightness.

SUMMARY OF THE INVENTION

The present invention is to solve the foregoing problem of the prior art technique, and intended to improve picture quality of X-ray photographic images.

To achieve the above-described problem, X-ray camera of this invention comprises:

an X-ray irradiation unit;

an X-ray image sensor;

a controller comprising a correction factor setting unit, a correction factor storage unit, and a correctional operation unit; and

a display unit.

The X-ray image sensor in the above configuration comprises:

a sensor such as CCD, TFT, and the like having a scintillator on a surface of it; and

a substrate having the sensor mounted thereon.

The correction factor setting unit (hereinafter referred to simply as "setting unit") obtains a value La/Ln for an arbitrary pixel "n" by dividing a predetermined brightness reference value La set beforehand by a brightness value Ln of the arbitrary pixel "n", and sets the obtained value as a correction factor of each pixel.

The correction factor storage unit (hereinafter referred to simply as "storage unit") stores the correction factor set by the setting unit.

The correctional operation unit (hereinafter referred to simply as "operation unit") obtains the correction factor from the storage unit, and performs a corrective operation.

The display unit displays an image, which is corrected by the operation unit.

The X-ray camera of this invention, with the configuration as described above, cancels errors in brightness caused by inherent dispersion of the sensors and image detector circuits peculiar to the X-ray camera, by making correction of brightness of the image obtained in the photography, and thereby it can realize substantial improvement in quality of the X-ray image.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an illustration depicting a configuration of X-ray camera of a first exemplary embodiment;

Fig. 2A is a diagrammatic illustration showing an aspect of taking an X-ray image of a subject 1 serving as a reference;

Fig. 2B is a diagrammatic illustration showing an example of brightness

distribution of the image of the subject 1 obtained with an X-ray image sensor 2 along a row of pixels in a one-dimensional direction;

Fig. 3A is a diagrammatic illustration showing an aspect of taking an X-ray image of a model subject;

Fig. 3B is a diagrammatic illustration showing an example of brightness distribution of the image, obtained with the X-ray image sensor by taking photograph of the model of step-wise configuration, along a row of pixels in a one-dimensional direction;

Fig. 3C is a diagrammatic illustration showing the brightness distribution after correction;

Fig. 4 is an illustration depicting an example of another configuration of the controller shown in Fig. 1;

Fig. 5 is a flow chart showing an operational flow of the X-ray camera of the first exemplary embodiment;

Fig. 6A is an expository illustration depicting operation of X-ray camera having a sensor configuration described in a third exemplary embodiment;

Fig. 6B is a diagrammatic illustration showing an example of brightness distribution of an image, obtained with the X-ray image sensor 2 of the third exemplary embodiment, along a row of pixels in a one-dimensional direction;

Fig. 6C is a diagrammatic illustration showing the brightness distribution after corrected according to the third exemplary embodiment;

Fig. 7A is an expository illustration depicting operation of X-ray camera having a sensor configuration described in a fourth exemplary embodiment;

Fig. 7B is a diagrammatic illustration showing an example of brightness distribution of an image, obtained with the X-ray image sensor 2 of the fourth

exemplary embodiment, along a row of pixels in a one-dimensional direction; and

Fig. 7C is a diagrammatic illustration showing the brightness distribution after corrected according to the fourth exemplary embodiment.

THE BEST MODE FOR CARRYING OUT THE INVENTION

With reference to accompanying figures, X-ray camera of the present invention will be described hereinafter.

(First Exemplary Embodiment)

Referring now to Fig. 1 through Fig. 5, a first exemplary embodiment of this invention is described hereinafter.

Fig. 1 is an illustration depicting a configuration of the X-ray camera of the first exemplary embodiment of this invention. As shown in Fig. 1, the X-ray camera of the first exemplary embodiment comprises:

an X-ray irradiation unit 100;

an X-ray image sensor 2;

a controller 200 comprising a setting unit 4, a storage unit 5, and an operation unit 6; and

a display unit 300.

A reference numeral 400 shown in Fig. 1 schematically illustrates a subject for the X-ray equipment.

As shown in Fig. 2A, an X-ray image sensor unit (hereinafter referred to simply as "sensor unit") 20 in the above configuration comprises:

an X-ray image sensor (hereinafter referred to simply as "sensor") 2 such as CCD, TFT, and the like having a scintillator on a surface of it (not shown in the figure); and

a substrate 7 having the sensor 2 mounted thereon.

A corrective operation of brightness of a photographed image displayed in the display unit 300 is described now.

Fig. 2A diagrammatically illustrates an aspect of taking an X-ray image of a reference subject 1. In Fig. 2A, when X rays are irradiated to the reference subject 1, the X rays penetrated through the subject 1 are converted into light signal by the scintillator (not show in the figure), and detected as an image by the sensor 2 mounted on the substrate 7.

Fig. 2B diagrammatically illustrates an example of brightness distribution along a row of pixels in a one-dimensional direction of the image of the reference subject 1 obtained by the sensor 2. Fundamentally, value of brightness shall be invariant from pixel to pixel. However, the value of brightness varies slightly from pixel to pixel as shown in Fig. 2B, due to an inherent dispersion of the sensor 2, detector circuits (not show in the figure), or the like.

Therefore, the setting unit 4 obtains a value La/Ln for an arbitrary pixel "n" by dividing a predetermined brightness reference value La by a brightness value Ln of the arbitrary pixel "n", and sets the obtained value as a correction factor of each pixel. Here, the brightness reference value La is a design value of the sensor 2, and therefore the value of brightness that should naturally be output.

The correction factor for each pixel obtained by taking the X-ray image of the reference subject 1 is stored in the storage unit 5.

Described next pertains to a corrective operation carried out according to the correction factor obtained above for brightness of an image taken by X-ray photographing a step-wise configuration model 3, which typifies a subject body. The step-wise configuration model 3 is composed of aluminum and the like, to

represent a subject body in place of a human body.

Fig. 3A diagrammatically illustrates an aspect of taking an X-ray image of the model serving as a subject body. In Fig. 3A, when X rays are irradiated to the step-wise configuration model 3, the X rays penetrated through the step-wise configuration model 3 are converted into light signal by the scintillator (not show in the figure), and detected as an image by the sensor 2 mounted on the substrate 7. Fig. 3B diagrammatically illustrates an example of brightness distribution along a row of pixels in a one-dimensional direction of the image obtained with the sensor 2 by taking photograph of the step-wise configuration model 3. Fundamentally, value of brightness shall be invariant from pixel to pixel. However, the value of brightness varies slightly from pixel to pixel as shown by a line Ln' in Fig. 3B, due to an inherent dispersion of the X-ray image sensor 2, detector circuits (not show in the figure), or the like.

Thus, the operation unit 6 obtains the correction factor from the storage unit 5, and implements a corrective operation by way of multiplication with the line Ln' of Fig. 3B. This operation yields the right brightness value (Ln' × La/Ln) for the image. Fig. 3C diagrammatically shows the corrected brightness distribution.

The corrected image is thus displayed in the display unit 300.

With the configuration as described above, the X-ray camera of this invention can substantially improve picture quality of the X-ray image by virtue of canceling errors in brightness caused by inherent dispersion of the sensors and the image detector circuits peculiar to the X-ray camera, through correction of brightness of the image obtained in the photography.

In this embodiment, as described above, the predetermined brightness reference value (design value) La was used to obtain the correction factor.

However, an average value of brightness of the entire image may be used as the reference value La. Alternatively, it is also acceptable to use a representative value of brightness of the entire image (e.g., a maximum value, a mean value, a minimum value, and the like) as the reference value. Fig. 5 shows an example of configuration of the controller in this case.

A setting unit 4 sets correction factors corresponding to three sorts of values, which are:

an average value of brightness;

a representative value of brightness; and

a predetermined reference brightness value for each pixel of an image obtained by taking an X-ray photograph of the reference subject. A storage unit 52 stores the three sorts of correction factors set as above. When making correction of brightness of an image obtained by taking an X-ray photograph of a subject body, the operation unit 6 obtains a corresponding correction factor among the three sorts of correction factors through a correction factor selection unit 6 in the storage unit 52.

As described above, brightness characteristic of the X-ray image sensor 2 actually in used can be corrected by virtue of making correction responsive to dispersion of the individual X-ray image sensor. An accuracy of displaying the image can thus be improved. Further, feature of individual operation process determines which one to use between the average value and the representative value. In other words, the average value is used when accuracy is required, and the representative value is used when a high-speed processing is needed.

Furthermore, there results in a better improvement of the accuracy when using the value obtained from the division as La/Ln for the correction factor to be

set for each pixel, as compared to the use of a difference like La – Ln, which can be influenced by intensity of external light, illumination, and so on.

As for a reference subject, it may be appropriate to use a soft-tissue equivalent material such as urethane resin and the like to represent muscles and adipose tissue, or a bone-tissue equivalent material such as epoxy resin, aluminum and the like.

Next, Fig. 5 shows an operational flow of the entire X-ray camera of the first exemplary embodiment of this invention.

Upon start of the X-ray camera, a selection is made between setting operation of a correction factor and photographing of a human body (step 1).

If step 1 selects the setting operation of a correction factor at a start of the X-ray camera, the system takes an X-ray photograph of the reference subject 1 (step 2).

The setting unit 4 calculates a correction factor for each pixel based on brightness data of the image obtained in step 2 (step 3).

The correction factor for each pixel obtained in step 3 is stored in the storage unit 5 comprised of a semiconductor memory, a hard disk, and the like (step 4). It returns to the initial state of the system, after the correction factor is stored.

If step 1 selects the subject body to be photographed, it takes an X-ray photograph of the human body (step 5).

The operation unit 5 obtains the correction factor for each pixel from the storage unit 5, and carries out a corrective operation based on the brightness data of the image taken in step 5 (step 6).

The display unit 300 displays the X-ray image after the corrective operation is made in step 6 (step 7).

The above steps 2, 3, and 4 can be initiated at any timing to reset the correction factor, when the equipment is first installed, when a user determines it necessary, and so on. If the correction factor has already been set and stored, the steps 1, 5, 6, and 7 are normally executed.

(Second Exemplary Embodiment)

A second exemplary embodiment relates to X-ray camera, which sets plural sorts of correction factors to be stored, as described in the first exemplary embodiment. It is so devised as to be capable of selecting which correction factor to use among those correction factors stored in a plurality of storage means, according to thickness of a portion of a human body to be photographed.

A configuration of a controller 202 of the second exemplary embodiment is analogous to the controller 202 shown in the first exemplary embodiment. Although there is a slight difference in function of their respective configurations, the following description will be made in this exemplary embodiment with reference to Fig. 4, since they are analogous in configuration.

The controller 202 of the second exemplary embodiment comprises a setting unit 4, a plurality of storage units 52 capable of storing correction factors, a selection unit 7 for selecting among the storage units 52 a correction factor corresponding to a portion of the subject to be irradiated with X-rays, and an operation unit 6.

In this exemplary embodiment, a photograph is taken by irradiating X rays to a reference subject according to a thickness of photographing portion of a human body to be measured, in the same manner as the first exemplary embodiment.

The setting unit 4 sets correction factors according to the result, in the same manner as the first exemplary embodiment. The storage units 52 then store the correction factors set as above.

When an X-ray photograph is taken for a portion of the subject human body, the operation unit 6 obtains a correction factor for each pixel based on brightness data of the acquired image from one of the storage units 52 that corresponds to the portion of the subject human body, through the selection unit 7, and carries out a corrective operation.

Th display unit 300 displays the X-ray image after the corrective operation is made.

Accordingly, the most appropriate correction factor can be chosen according to thickness of the photographing portion of the human body, when the plurality of correction factors having several sorts of different thicknesses of the reference subject are set and stored.

If photographs are taken for two kinds of equivalent materials, a soft-tissue equivalent material and a bone-tissue equivalent material, for instance, the setting unit 4 sets two sorts of correction factors corresponding to the respective equivalent materials. The storage units 52 store the two sorts of correction factors set as above. When making a correction of brightness of the image acquired by taking an X ray photograph of the subject body, the operation unit 6 obtains a correction factor for each pixel from one of the storage units 52, which corresponds to the portion of the subject human body, through the selection unit 7, and carries out the corrective operation.

Th display unit 300 can then display the X-ray image after the corrective operation is made.

(Third Exemplary Embodiment)

A third exemplary embodiment relates to X-ray camera for taking an X ray photograph with a plurality of X-ray image sensors arranged in an overlapped manner. Fig. 6A shows an example in which a plurality of sensors are arranged so as to overlap with one another at the analogous portions.

As shown in Fig. 6A, three sets of the X-ray image sensor 2 are arranged in a manner that an effective image-capture area (i.e. an area normally narrower than an overall perimeter of the X-ray image sensor) of each of the X-ray image sensors overlaps with one another, in order to detect an image without any dropout portion. It is so designed that an image captured by the sensor located at the front side toward the subject is taken for the image of the overlapped portion. When X rays are irradiated, a portion between an effective image-capture area and a perimeter of the front side sensor gives a shadow on an effective image-capture area of the sensor placed behind the front one, as shown in Fig. 6B. This causes a phenomenon of partially decreasing the brightness only in the area of this shadow. This phenomenon is the largest problem in the X-ray photography with the plurality of X-ray image sensors arranged in the overlapped manner.

The X-ray camera of the third exemplary embodiment obtains a correction factor for each of arbitrary pixel "n", and carries out a corrective operation for each pixel, in the same manner as described in the first exemplary embodiment. Accordingly, it is proved effective even when the plurality of sensors, arranged in the overlapped manner, are used as the X-ray image sensor, and satisfactory correction of brightness can be achieved, as shown in Fig. 6C.

(Fourth Exemplary Embodiment)

A fourth exemplary embodiment relates to X-ray camera for taking an X ray photograph with a plurality of X-ray image sensors arranged in an overlapped manner. Fig. 7A shows an example in which a plurality of sensors are arranged in a step-wise manner at the analogous portions.

When X rays are irradiated, a portion between an effective image-capture area and a perimeter of the front side sensor produces a shadow as shown in Fig. 7B on an effective image-capture area of the sensor placed behind the front one, in the like reason as the third exemplary embodiment. This causes a phenomenon of partially decreasing the brightness only in the area of this shadow. This phenomenon is the largest problem in the X-ray photography with the plurality of X-ray image sensors arranged in the overlapped manner.

The X-ray camera of the fourth exemplary embodiment obtains a correction factor for each of arbitrary pixel "n", and carries out a corrective operation for each pixel, in the same manner as described in the first exemplary embodiment. As described, it is proved effective even when the plurality of sensors, arranged in the overlapped manner, are used as the X-ray image sensor, and thereby satisfactory correction of brightness can be achieved, as shown in Fig. 7C.

INDUSTRIAL APPLICABILITY

As has been described, the X-ray camera according to this invention cancels errors in brightness caused by inherent dispersion of the sensors and image detector circuits peculiar to the X-ray camera, by providing a correctional function for brightness of an image obtained in the photography, and thereby it can realize substantial improvement in quality of the X-ray image.

Moreover, it provides for a possibility of correcting image quality precisely according to the subject and portion being photographed, by allowing selection of a method of calculating the correction factor, and a plural kinds of reference subject to be used for setting the correction factor based on a purpose of the photograph.

Accordingly, it is extremely useful for radiographic diagnosis in the medical field.

In addition, it is also adaptable for the correction of brightness in the overlapped area of sensors, in the case of equipment that uses a combination of plural sensors for the purpose of obtaining a wide photographable area, and therefore it is extremely useful again for radiographic diagnosis in the medical field.

P22599 Substitute

CLAIMS

1. X-ray camera having an image correction means for correcting brightness of an image obtained by taking an X-ray photograph of a subject body, using a correction factor acquired from a brightness data representing gradation of an image obtained by taking an X-ray photograph of a reference subject.

2. The X-ray camera as set forth in claim 1, wherein said correction factor acquired from the brightness data representing gradation of the image obtained by taking the X-ray photograph of said reference subject is set therein for each pixel individually.

3. The X-ray camera as set forth in claim 2, wherein a value acquired by dividing a predetermined brightness reference value with a brightness value of each pixel in the image obtained by taking the X-ray photograph of said reference subject is used as a pixel correction factor for said pixel.

4. The X-ray camera as set forth in claim 3, wherein said image correction means corrects brightness of each pixel by multiplying a brightness value of said pixel in the image obtained by taking the X-ray photograph of said subject body by said pixel correction factor of the corresponding pixel acquired by taking the X-ray photograph of said reference subject.

5. The X-ray camera as set forth in claim 2, wherein a value acquired by dividing an average value of brightness of the image obtained by taking the X-ray

photograph of said reference subject with the brightness value of each pixel is used as a pixel correction factor for said pixel.

6. The X-ray camera as set forth in claim 5, wherein said image correction means corrects brightness of each pixel by multiplying a brightness value of said pixel in the image obtained by taking the X-ray photograph of said subject body by said pixel correction factor of the corresponding pixel acquired by taking the X-ray photograph of said reference subject.

7. The X-ray camera as set forth in claim 2, wherein a value acquired by dividing a representative value of brightness of the image obtained by taking the X-ray photograph of said reference subject with the brightness value of each pixel is used as a pixel correction factor for said pixel.

8. The X-ray camera as set forth in claim 7, wherein said image correction means corrects brightness of each pixel by multiplying a brightness value of said pixel in the image obtained by taking the X-ray photograph of said subject body by said pixel correction factor of the corresponding pixel acquired by taking the X-ray photograph of said reference subject.

9. The X-ray camera as set forth in claim 2, wherein a soft-tissue equivalent material representing muscles and adipose tissue, composed of urethane resin and the like, is used as a reference subject for acquiring said correction factor.

10. The X-ray camera as set forth in claim 2, wherein a bone-tissue equivalent material composed of epoxy resin, aluminum and the like is used as a reference subject for acquiring said correction factor.

11. The X-ray camera as set forth in claim 2 comprising a storage means for storing a pixel correction factor for each pixel obtained by taking the X-ray photograph of said reference subject, and a correction factor setting means for setting a correction factor, other than ordinary X-ray photography, in order to acquire said correction factor, wherein said X-ray camera can be operated for resetting a correction factor at an arbitrary timing when said equipment is first installed, when a user determines it necessary, and so on.

12. X-ray camera comprising:

a storage means for storing a pixel correction factor for each pixel obtained by taking an X-ray photograph of a reference subject;

a correction factor setting means for setting a correction factor, other than ordinary X-ray photography, in order to acquire said pixel correction factor; and

a correction means for correcting brightness of an image obtained by taking an X-ray photograph of a subject body using said correction factor,

wherein said storage means stores three sorts of correction factors obtained by dividing each of three values by a brightness value of each pixel, said three values being an average value and a representative value of brightness of an image obtained by taking the X-ray photograph of said reference subject, and a predetermined reference brightness value , and

said correction factor setting means selects one correction factor among said three sorts of correction factors when making correction of brightness of the image obtained by taking the X-ray photograph of said subject body.

13. X-ray camera comprising:

a storage means for storing a correction factor for each pixel obtained by taking an X-ray photograph of a reference subject;

a correction factor setting means for setting a correction factor, other than ordinary X-ray photography, in order to acquire said correction factor; and

a correction means for correcting brightness of an image obtained by taking an X-ray photograph of a subject body using said correction factor,

wherein said storage means stores two sorts of correction factors corresponding to a soft-tissue equivalent material and a bone-tissue equivalent material by taking photographs of said two equivalent materials, and

said correction factor setting means selects one correction factor between said two sorts of correction factors when making correction of brightness of the image obtained by taking the X-ray photograph of said subject body.

14. The X-ray camera as set forth in claim 1, wherein a plurality of X-ray image sensors are arranged in a manner that a portion of photographed image overlaps with one another, in order to take an X-ray image of an expanded size without an error of brightness in the overlapped portion.

ABSTRACT

X-ray camera of the present invention comprises an X-ray irradiation unit, an X-ray image sensor, a controller having a correction factor setting unit, a correction factor storage unit and a correctional operation unit, and a display unit. The X-ray image sensor in the above configuration comprises a sensor such as CCD, TFT, and the like having a scintillator on a surface thereof, and a substrate having the sensor mounted thereon. The correction factor setting unit obtains a value La/Ln by dividing a predetermined brightness reference value La set beforehand by a brightness value Ln of an arbitrary pixel "n", and sets the obtained value as a correction factor for each pixel. The correction factor storage unit stores the correction factor set by the correction factor setting unit. The correctional operation unit obtains the correction factor from the correction factor storage unit, and performs a corrective operation.

Fig.1

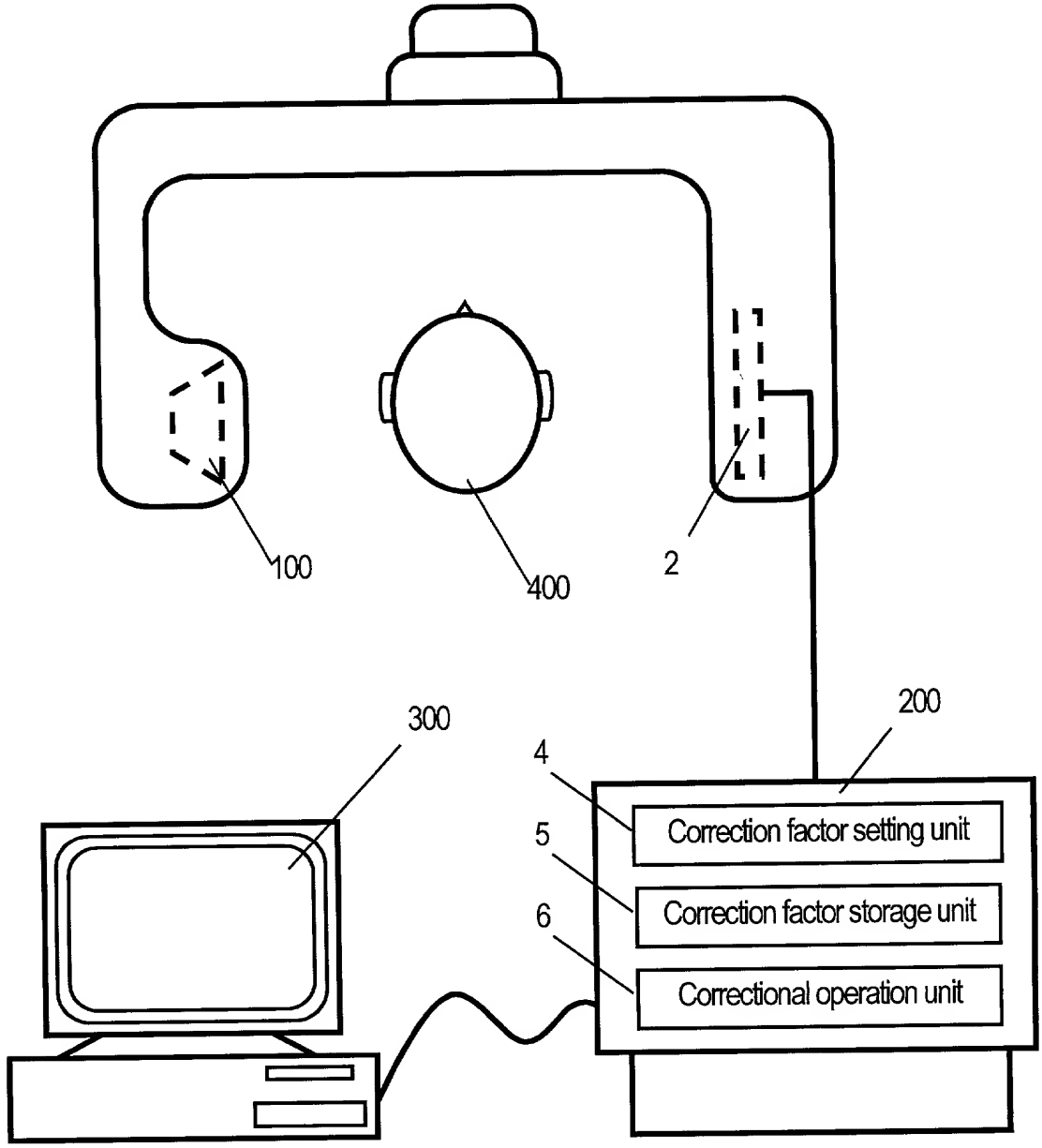

100
400
2
300
200
4
Correction factor setting unit
5
Correction factor storage unit
6
Correctional operation unit

Fig.2A

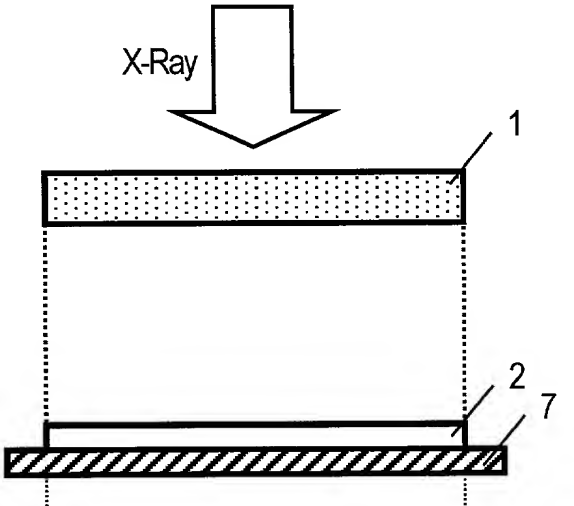


Fig.2B

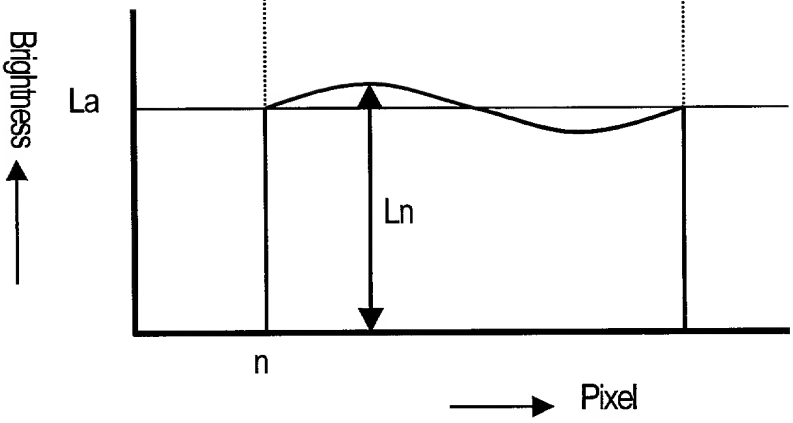


Fig.3A

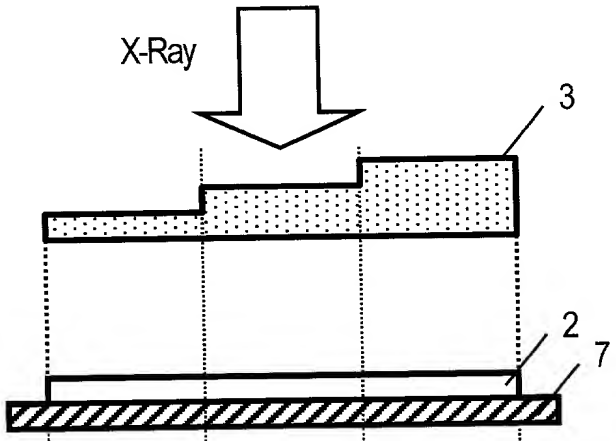


図３Ｂ

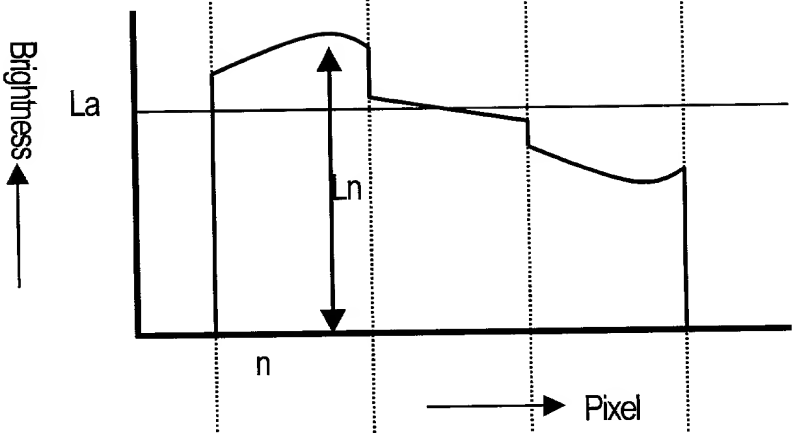


Fig.3C

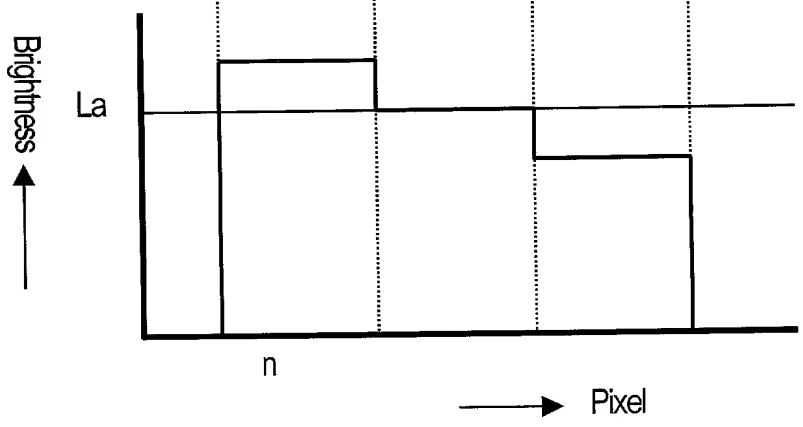


Fig.4

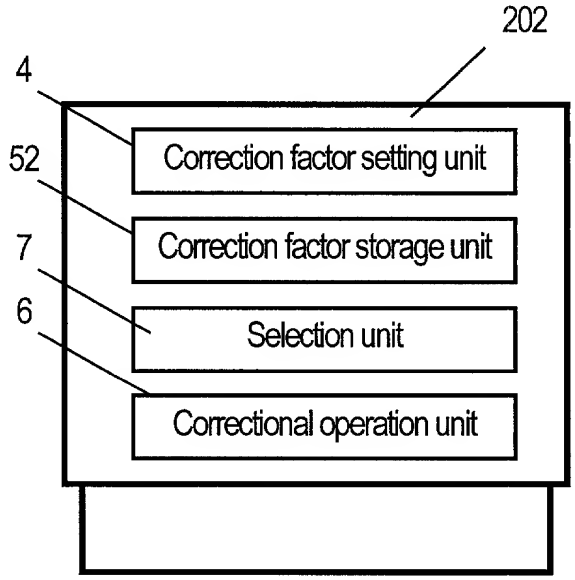

202
4
Correction factor setting unit
52
Correction factor storage unit
7
Selection unit
6
Correctional operation unit

Fig.5

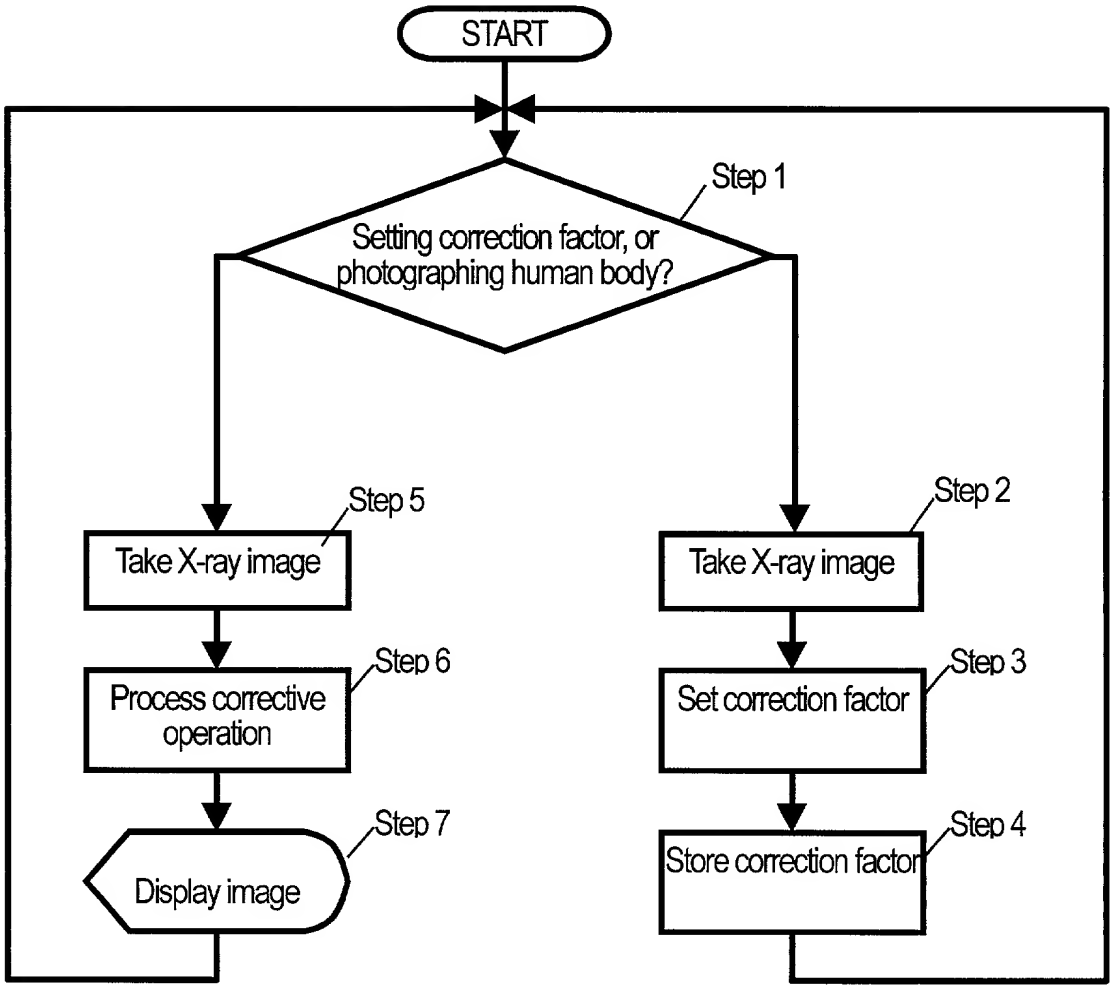

START
Step 1
Setting correction factor, or photographing human body?
Step 5
Take X-ray image
Step 6
Process corrective operation
Step 7
Display image
Step 2
Take X-ray image
Step 3
Set correction factor
Step 4
Store correction factor

Fig.6A

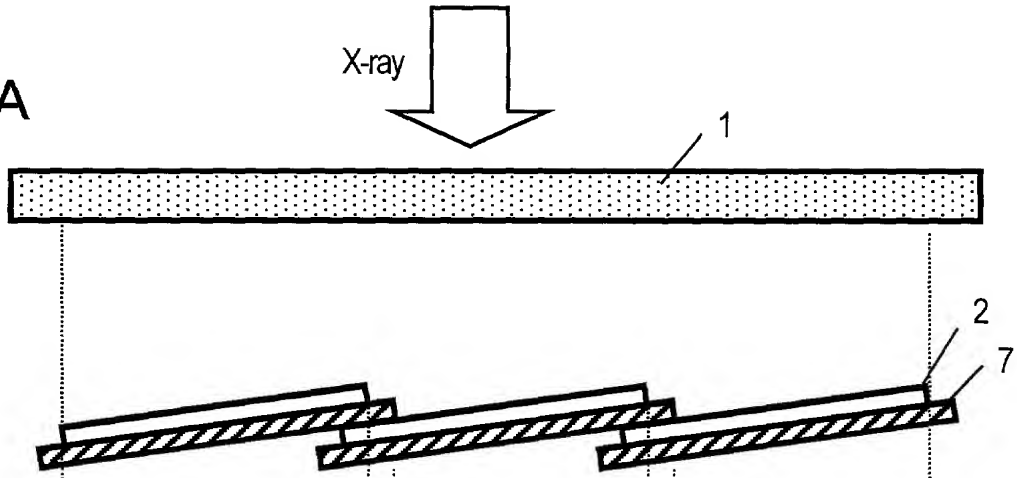
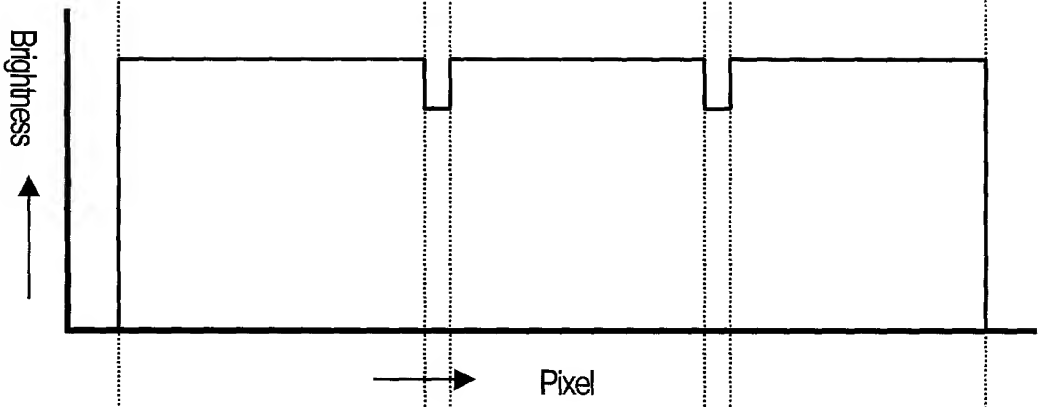


Fig.6B



Correction

Fig.6C

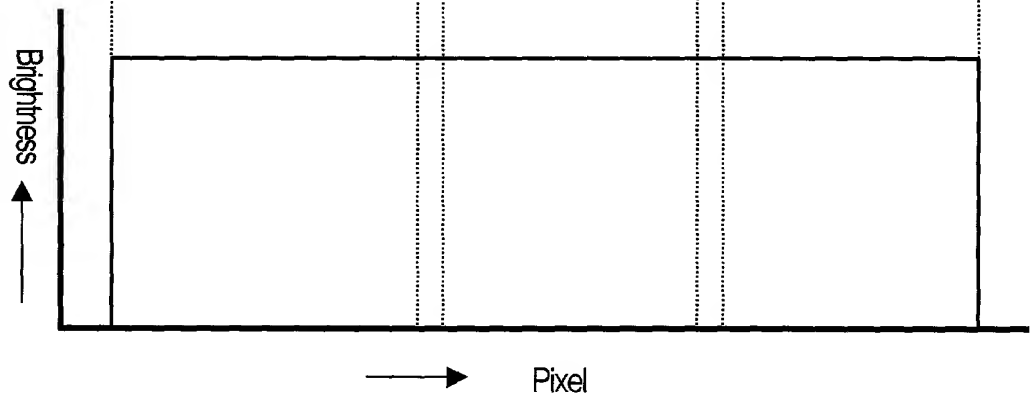


Fig.7A

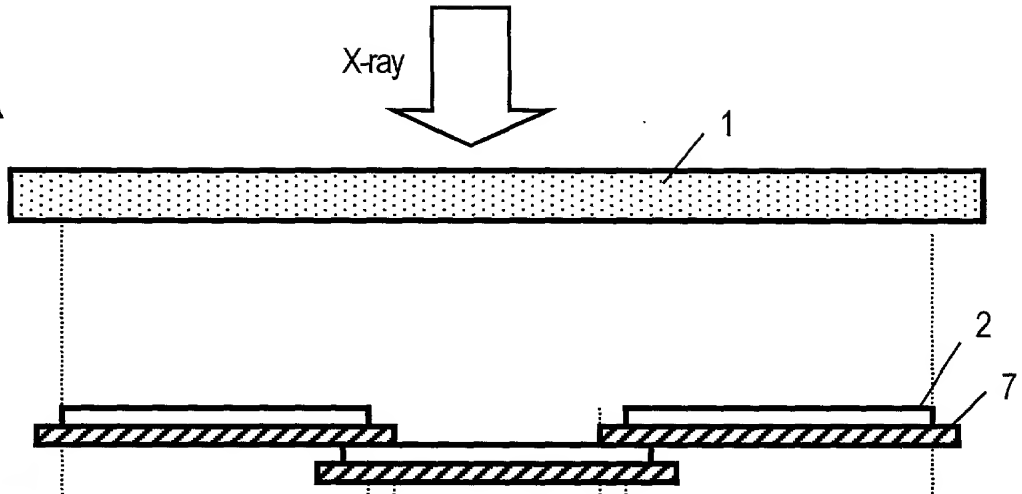
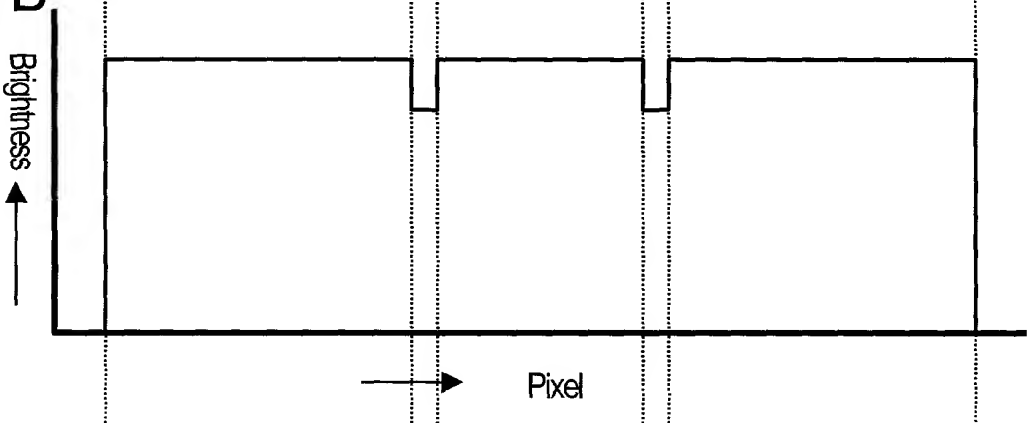
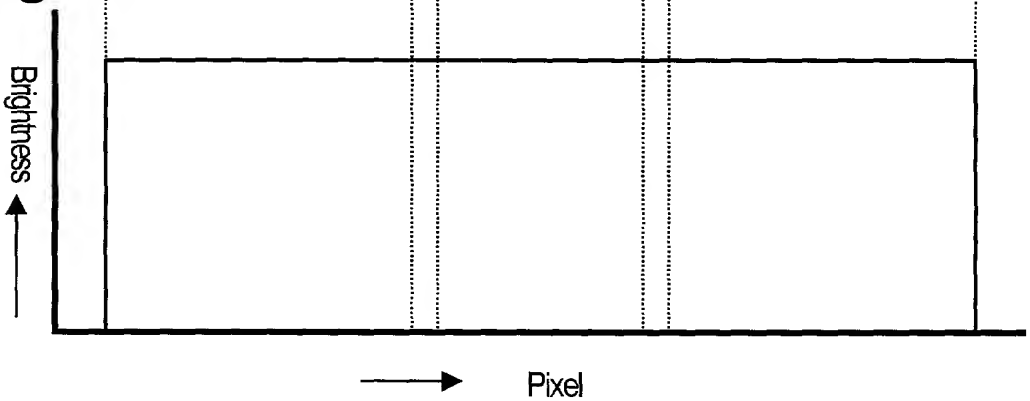


Fig.7B



Correction

Fig.7C



REFERENCE NUMERALS

1. Reference subject
2. X-ray photographic sensor
3. Model subject of step-wise configuration (Subject body)
4. Correction factor setting unit
5. Correction factor storage unit
52. Correction factor storage unit
6. Correctional operation unit
7. Selection unit
100. X-ray irradiation unit
200. Controller
202. Controller
300. Display unit
400. Schematically illustrated subject

(Includes Reference to PCT International Application(s) | 43890-466

As below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

X-RAY CAMERA

the specification of which:

☐ is attached hereto.

☒ was filed as United States application Serial No. 09/701,479

on November 29, 2000

and was amended on November 29, 2000 (if applicable).

☒ was filed as PCT international application Number PCT/JP00/01784

on March 23, 2000

☐ and was amended under PCT Article 19 on June 28, 2000 (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is known to me to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) or Section 365(b) of any foreign and/or international application(s) for patent or inventor's certificate or Section 365(a) of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (If PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
JAPAN	11/85844	March 29, 1999	☒Yes ☐ No

I hereby claim the benefit under 35 USC §119(e) of any United States provisional application(s) listed below.

PRIOR PROVISIONAL APPLICATION(S):

Application Number	Filing Date

I hereby claim the benefit under Title 35, United States Code, [illegible] designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/these prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application.

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS		STATUS (Check One)		
U.S. Application Number	U.S. Filing Date	Patented	Pending	Abandoned

PCT APPLICATIONS DESIGNATING THE U.S.					
PCT Application No.	PCT Filing Date	U.S. Serial Numbers Assigned (if any)			
PCT/JP00/01784	March 23, 2000				

POWER OF ATTORNEY: As named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Stephen A. Becker, Reg. No. 26,527; John G. Bisbikis, Reg. No. 37,095; Christopher D. Bright, Reg. No. 46,578; Daniel Bucca, Reg. No. 42,368; Kenneth L. Cage, Reg. No. 26,151; Jennifer Chen, Reg. No. 42,404; Bernard P. Codd, Reg. No. 46,429; Thomas A. Conrado, Reg. No. 42,439; Lawrence T. Cullen, Reg. No. 44,489; Paul Devinsky, Reg. No. 28,553; Margaret M. Duncan, Reg. No. 30,879; Ramyar M. Farid, Reg. No. 46,692; Brian E. Ferguson, Reg. No. 36,801; Michael E. Fogarty, Reg. No. 36,139; John R. Fuisz, Reg. No. 37,327; Willem F. Gadiano, Reg. No. 37,135; Keith E. George, Reg. No. 34,111; Matthew V. Grumbling, Reg. No. 44,427; John A. Hankins, Reg. No. 32,029; Joseph Hyosuk Kim, Reg. No. 41,425; Eric J. Kraus, Reg. No. 36,190; Catherine Krupka, Reg. No. 46,227; Jack Q. Lever, Reg. No. 28,149; Raphael V. Lupo, Reg. No. 28,363; Michael A. Messina, Reg. No. 33,424; Dawn L. Palmer, Reg. No. 41,236; Joseph H. Paquin, Jr., Reg. No. 31,647; Scott D. Paul, Reg. No. 42,984; William D. Pegg, Reg. No. 42,988; Robert L. Price, Reg. No. 22,685; Thomas D. Robbins, Reg. No. 43,669; Gene Z. Rubinson, Reg. No. 33,351; Joy Ann G. Serauskas, Reg. No. 27,952; Daniel H. Sherr, Reg. No. 46,425; David A. Spenard, Reg. No. 37,449; Arthur J. Steiner, Reg. No. 26,106; David L. Stewart, Reg. No. 37,578; Wesley Strickland, Reg. No. 44,363; Michael D. Switzer, Reg. No. 39,552; Leonid D. Thenor, Reg. No. 39,397; Daniel S. Trainor, Reg. No. 43,959; Cameron K. Weiffenbach, Reg. No. 44,488; Aaron Weisstuch, Reg. No. 41,557; Edward J. Wise, Reg. No. 34,523; Alexander V. Yampolsky, Reg. No. 36,324; and Robert W. Zelnick, Reg. No. 36,976, all of McDermott, Will & Emery.

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I hereby declare that all statement made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signature of Inventor 201:	Signature of Inventor 202:	Signature of Inventor 203:
Toshiyoshi Yamamoto	Takuo Shimada	Atsushi Sakata
Date January 17, 2001	Date January 17, 2001	Date January 17, 2001

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s), or §365(c) of any PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application.

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U.S. Application Number	U.S. Filing Date	Patented	Pending	Abandoned

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	Residence and Citizenship	City	State or Foreign Country	Country of Citizenship	
	Post Office Address	Post Office Address	City	State & Zip Code/Country	

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Signature of Inventor 204:	Signature of Inventor 205:	Signature of Inventor 206:
Kazuya Kondo	Yoshihiro Ino	
Date January 17, 2001	Date January 17, 2001	Date